AYK REGION
BOF RPT #43

MEMORANDUM STATE OF ALASKA

To: Yukon Area Staff
Commercial Fisheries

Date: November 13, 1985

File No:

Phone No: 267-2124

From: Larry Buklis
Yukon Research Biologist
Commercial Fisheries
Anchorage

Subject: Fall Chum Salmon Data Analysis for Board Meeting

At our staff meeting on November 4 I was assigned to compare Main River Sonar fall chum salmon counts to upriver catch and escapement, assess the relationship between age 3 abundance and subsequent year return, and determine the reduction in harvest necessary to achieve escapement objectives.

The preliminary Main River Sonar count of 330,000 chum salmon between 20 July and 25 August, 1985 is only 60% of the harvest and observed escapement of fall chum salmon above the sonar site (Table 1). An additional 153,216 fall chums were harvested below the sonar site. Dave Mesiar does not anticipate that the final sonar estimate will differ very much from this preliminary estimate. Since escapements for several spawning areas were assessed by index aerial or foot survey, and not all spawning areas are surveyed, the 60% figure is a maximum estimate of sonar accuracy. An additional 110,000 coho salmon were enumerated by sonar during this same time period.

The last two tasks require an estimate of total return. I added commercial catch (Alaska and Canada combined), subsistence catch (Alaska and Canada combined), and an escapement index to obtain an index of total return for the years 1974-1985 (Table 2). The escapement index is the sum of total season escapement to the Sheenjek, Fishing Branch, Toklat, Delta Rivers, and Bluff Cabin Slough. Sonar and weir counts were used when available. Aerial and foot survey indices were converted to total season escapement estimates as outlined in Tables 3-7. Our escapement objectives, which are in terms of aerial survey index counts, were converted to total season escapement objectives using these same expansion factors (Table 8). While these expansion factors are based on very limited data and some educated guesses, they are necessary in order to make catch and escapement data more directly comparable. The resulting total return estimates are still only an index since not all spawning populations are included in the escapement component.

Age composition of the District 1 commercial 6" gillnet fishery sample for each year was multiplied by the return index for that year to estimate return by age class (Table 2). The list of assumptions involved with this approach is longer than this page, but given the time constraints of this assignment and the incompleteness of the data base, a more rigorous escapement-return analysis could not be done. Simple linear regression r-squared values were between 0.32 and 0.62 for the relationship between the escapement index and return four years later, age 3 abundance and total return or age 4 return the following year, and age 4 abundance and age 5 return the following year (Figures 1-4). None of these relationships is significant enough to allow us to predict the 1986 return based on strength of the 1982 parent year escapement or age composition of the 1985 return. A more refined approach to this problem might very well eliminate some of the variability in these regressions. But at this point in time we have to say we just don't know what the 1986 return will be, and have no predictive model to help us.

Lets not let that stop us. What we can do is present a series of possible scenarios for 1986, and the level of subsistence and commercial harvest that could be supported with each. I have generated graphs showing trends in harvest, escapement, and exploitation rate for the period 1974-1985 (Figures 5-8). Two points are worth mentioning:

1. While total return abundance has been highly variable during this 12 year period, exploitation rate has been greater during the last 6 years. We have been harvesting a greater proportion of the return recently than during the mid-1970's. A good return and conservative harvest strategy reversed this trend in 1985.

2. The escapement index was lowest in 1982, and not much better in 1984. The very strong escapements in 1975 and 1979 did not materialize in 1983 due to a high exploitation rate. Annual trends in the pooled escapement index are not necessarily reflected in each of the contributing spawning areas.

The pooled escapement objective for the five spawning areas used in this analysis (converted to total season counts) is 157,000 fall chum salmon (Table 8). Given recent subsistence harvests and the anticipated weak return in 1986, subsistence harvest in 1986 is projected to be 150,000 fall chums in Alaska and Canada combined (a necessary guess at this point in the discussion). Given these escapement and subsistence needs (Figure 8), we can project allowable commercial harvest for Alaska and Canada combined for total returns of various magnitudes (Table 9). I have chosen these hypothetical return magnitudes for 1986 as percentages of the 1982 parent year return. Any hypothetical run size for 1986 could be run through this formula. We don't as yet have measures of total abundance by which to manage the fishery on an in-season basis (Main River Sonar may meet this need), instead relying on test fishing indices. Therefore, we may be able to determine that the 1986 run is developing at only half the strength of the 1982 return, without knowing in absolute terms the magnitude of either return. If the 1986 return is only 25% of the 1982 return, escapement objectives would not be achieved even with a total closure of subsistence and commercial fisheries (Table 9). At 50% of 1982 run strength, escapement objectives could be achieved with a 58,000 fish subsistence fishery and no commercial harvest. At 75% of 1982 run strength, escapement objectives and a 150,000 fish subsistence harvest could be achieved, with essentially no commercial harvest (only 15,000 fish). Finally, if the 1986 return was equal to the 1982 return, escapement and subsistence needs could be met with 123,000 fall chums available for commercial harvest.

These may not be the kind of ultimate answers we wanted, but I think its about as far as we can go with the data we have available. I will make overhead projector transparencies of these figures and bring them to the Board meeting. This material might best be presented as backup justification to Proposal #150, if necessary, and not as part of the regular oral presentations by Dan, Fred, and Louis.

Attachments

cc: Regnart
Arvey
Brannian
McBride

ıle 1 . Yukon River fall chum salmon catch and escapement, 1985, compared to Main River Sonar counts.

Location	Fall Chums		
Y-1 Commercial	129,948		
Y-21+2+3 Commercial	23,268		
Y-1 to Y-23 Subsistence a	20,000		
Subtotal (Below Main R)	153,216		
Y-24+5 Commercial	17,222		
Y-3 Commercial	5,164		
Y-4 Commercial	26,977		
Y-5 Commercial	25,338		
Y-6 Commercial	42,352		
Y-24 to Y-6 Subsistence a	172,000		
Canada Commercial	32,000		
Canada Subsistence a	8,000		
Sheenjek Sonar	117,668		
Fishing Branch Weir	56,100		
uane Foot Survey	3,000		
꜀klat Foot Survey	21,824		
Delta Foot Survey	16,158		
Other Tanana Drainage b	6,461		
Subtotal (Above Main R)	550,264	Main River Sonar Count	330,000
YUKON RIVER DRAINAGE TOTAL	703,480		

a Subsistence catch data not yet available for 1985. Used a conservative estimate of 20,000 fall chum salmon below the sonar site, 172,000 above the sonar site in Alaska, and 8,000 in Canada.

b Sum of aerial survey counts for Benchmark, Bluff Cabin, and Onemile Sloughs, South Bank Tanana, and Clearwater Lake Outlet.

Table 2. Total return index of Yukon River fall chum salmon, based on harvest and expanded escapement indices for selected spawning areas, 1974-1985.

Year	Commercial Catch a	Subsistence Catch b	Escapement Index c	Index of Return d	Maximum Exploit Rate e	Prop Age 3 f	Number Age 3 g	Prop Age 4 f	Number Age 4 g	Prop Age 5 f	Number Age 5 g	9 5
1974	292,786	103,923	205,125	601,834	0.6592	0.438	263,603	0.534	321,379	0.029	17,453	
1975	277,509	97,902	690,753	1,066,164	0.3521	0.014	14,926	0.977	1,041,643	0.005	5,331	
1976	157,390	78,998	149,629	386,017	0.6124	0.111	42,848	0.361	139,352	0.529	204,203	14
1977	261,976	91,260	224,510	577,746	0.6114	0.095	54,886	0.851	491,662	0.053	30,621	17
1978	248,646	106,077	172,701	527,424	0.6726	0.199	104,957	0.660	348,100	0.139	73,312	12
1979	387,496	246,347	547,206	1,181,049	0.5367	0.073	86,217	0.878	1,036,961	0.050	59,052	10
1980	307,450	185,657	144,777	637,884	0.7730	0.137	87,390	0.782	498,825	0.082	52,307	4
1981	492,996	195,354	171,353	859,703	0.8007	0.014	12,036	0.876	753,100	0.111	95,427	14
1982	236,150	136,356	56,841	429,347	0.8676	0.060	25,761	0.620	266,195	0.315	135,244	14
1983	333,652	196,030	125,508	655,190	0.8084	0.006	3,931	0.872	571,326	0.122	79,933	22
1984	233,491	180,894	87,100	501,485	0.8263	0.074	37,110	0.591	296,378	0.330	165,490	22
1985	302,269	200,000	237,494	739,763	0.6790	0.006	4,439	0.853	631,018	0.134	99,128	25
1986		150,000	156,910									

a Commercial harvest in Alaska and Canada combined. Includes "equivalent fish" converted from roe sales. Data are from IL No. 239 for 1974-1983, from 1984 AMR for 1984, and from 1985 Board Report for 1985.

b Subsistence harvest in Alaska and Canada combined. Data sources same as for the commercial catch data. Data shown for 1986 is a projection based on recent harvests and the anticipated strength of the 1986 return.

c Escapement index is the sum of total season escapement to the Sheenjek, Fishing Branch, Toklat, Delta Rivers, and Bluff Cabin Slough. Sonar and weir counts used when available. Aerial and foot survey counts expanded to total season estimates as outlined in backup tables. Data sources are same as for commercial catch data. Data shown for 1986 is the escapement objective for these five spawning areas combined, expanded from indices of abundance to total abundance as outlined in backup table.

d Sum of commercial harvest, subsistence harvest, and the escapement index. This is only an index of total return since not all spawning populations are included in the escapement index.

e Sum of commercial and subsistence harvest divided by the index of total return. This is a maximum estimate of harvest exploitation rate since the escapement index is a minimum estimate.

f Proportion of age 3, age 4, or age 5 in the District 1 commercial 6" gillnet fishery sample. Data are from IL No. 239 for 1974-1982, TDR No. 119 for 1983, TDR No. 148 for 1984, and from preliminary data files for 1985.

g Index of total return multiplied by the proportion age 3, age 4, or age 5 in the District 1 commercial gillnet fishery sample.

Table 3. Sheenjek River fall chum salmon escapement counts, 1974-1985.

Year	Aerial Survey	Expansion Factor a	Season Estimate
1974	40,507	2.13	86,280
1975	78,060	2.13	166,268
1976	11,866	2.13	25,275
1977	20,506	2.13	43,678
1978	14,610	2.13	31,119
1979	41,140	2.13	87,628
1980	13,027	2.13	27,748
1981			69,043
1982			29,093
1983			45,733
1984			25,120
1985			117,668

a Expansion factor of 2.13 is based on relationship between sonar and aerial survey counts in 1983 (45,733/22,230=2.06) and 1984 (25,120/11,402=2.20). Season estimates for 1981-1985 are based on sonar counts, no expansion factor is needed.

Table 4. Fishing Branch River fall chum salmon escapement counts, 1974-1985.

Year	Aerial Survey	Expansion Factor a	Season Estimate
1974			32,525
1975			353,282
1976	13,450	2.72	36,584
1977	32,500	2.72	88,400
1978	15,000	2.72	40,800
1979	44,080	2.72	119,898
1980	20,319	2.72	55,268
1981	10,549	2.72	28,693
1982	5,846	2.72	15,901
1983	10,000	2.72	27,200
1984	5,570	2.72	15,150
1985			56,100

a Expansion factor of 2.72 is based on relationship between weir and aerial survey counts in 1975 (353,282/130,000=2.72). Season estimates for 1974, 1975, and 1985 are based on weir counts, and no expansion factor is needed.

ɟle 5. Toklat River fall chum salmon escapement counts, 1974-1985.

Year	Survey a	Expansion Factor b	Season Estimate
1974	34,310 A	2.00	68,620
1975	78,285 A	2.00	156,570
1976	35,190 A	2.00	70,380
1977	21,800 A	2.00	43,600
1978	35,000 A	2.00	70,000
1979	161,090 A+F	2+1.5	309,680
1980	23,054 A	2.00	46,108
1981	13,907 A	2.00	27,814
1982	3,309 F	1.50	4,964
1983	15,105 F	1.50	22,658
1984	15,861 A+F	2+1.5	22,314
1985	21,824 A+F	2+1.5	34,179

a Aerial (A) or foot (F) survey index counts.
b No empirical data is available on the relationship between aerial and/or foot survey counts and the total season escapement. Expansion factors of 2.00 for aerial survey and 1.50 for foot survey were arbitrarily chosen as reasonable estimates of this relationship. Those years for which part of the spawning area was surveyed by air and part by foot, each expansion factor was applied to the appropriate portion of the data.

Table 6. Delta River fall chum salmon escapement counts, 1974-1985.

Year	Survey a	Expansion Factor b	Season Estimate
1974	4,010 A	2.00	8,020
1975	3,089 F	1.50	4,634
1976	5,498 A	2.00	10,996
1977	17,925 A	2.00	35,850
1978	10,051 A	2.00	20,102
1979	8,125 A	2.00	16,250
1980	4,637 A	2.00	9,274
1981	22,375 F	1.50	33,563
1982	3,433 F	1.50	5,150
1983	7,230 F	1.50	10,845
1984	12,327 F	1.50	18,491
1985	16,158 F	1.50	24,237

a Aerial (A) or foot (F) survey index counts.
b No empirical data is available on the relationship between aerial and/or foot survey counts and the total season escapement. Expansion factors of 2.00 for aerial surveys and 1.50 for foot surveys were arbitrarily chosen as reasonable estimates of this relationship.

.e 7 . Bluff Cabin Slough fall chum salmon escapement counts, 1974-1985.

Year	Survey a	Expansion Factor b	Season Estimate
1974	4,840 A	2.00	9,680
1975	5,000 A	2.00	10,000
1976	3,197 A	2.00	6,394
1977	6,491 A	2.00	12,982
1978	5,340 A	2.00	10,680
1979	6,875 A	2.00	13,750
1980	3,190 A	2.00	6,380
1981	6,120 A	2.00	12,240
1982	1,156 F	1.50	1,734
1983	12,715 F	1.50	19,073
1984	4,017 F	1.50	6,026
1985	2,655 A	2.00	5,310

a Aerial (A) or foot (F) survey index counts.
b No empirical data is available on the relationship between aerial and/or foot survey counts and the total season escapement. Expansion factors of 2.00 for aerial surveys and 1.50 for foot surveys were arbitrarily chosen as reasonable estimates of this relationship.

Table 8 . Expanded fall chum salmon escapement objectives for selected spawning areas in the Yukon River drainage. a

Spawning Area	Index Count Objective	Expansion Factor	Total Season Objective
Sheenjek River	19,000	2.13	40,470
Fishing Branch R	17,000	2.72	46,240
Toklat River	22,000	2.00	44,000
Delta River	7,900	2.00	15,800
Bluff Cabin Slough	5,200	2.00	10,400
Total	71,100		156,910

a Escapement objectives are from 1984 AMR (except for Fishing Branch River, which is from Barton memo dated 23 May, 1984), and are in terms of peak aerial survey counts. Expansion factors for each stream are from backup tables.

Table 9. Allowable harvest of Yukon River fall chum salmon (Alaska and Canada combined) in 1986 given various levels of return abundance.

1986 Return Index Relative to 1982	1986 Return Index	Escapement Index a	Subsistence Harvest a	Commercial Harvest a
25%	107,000	107,000	0	0
50%	215,000	157,000	58,000	0
75%	322,000	157,000	150,000	15,000
100%	430,000	157,000	150,000	123,000

a In this simple model, all fish in the return are allocated to the escapement index until the pooled escapement objective of 157,000 fall chum salmon is met. Surplus fish are then allocated to the subsistence fishery. When the anticipated subsistence need of 150,000 fall chums is met, additional fish are then allocated to commercial harvest. In reality, the commercial and subsistence fisheries are occurring simultaneously, followed later by the spawning escapements. This requires assessment of run strength as the run is in progress, and selection of the appropriate harvest strategy.

Figure 1.

Simple Linear Regression Worksheet
limit is 100 observations

Obs. Number	X	Y	Pred. Y	Residual	lower 80% C.I.	upper 80% C.I.	St. Dev. Prediction
1.00	205125	527424	623778	-96354	260352	987204	206492.2
2.00	690753	1181049	1019274	161775	489699	1548849	300894.9
3.00	149629	637884	578582	59302	224513	932651	201175.3
4.00	224510	839703	639565	220138	272252	1006878	208700.6
5.00	172701	429347	597372	-168025	239740	955004	203200.1
6.00	547206	655190	902369	-247179	433491	1371247	266407.8
7.00	144777	501485	574631	-73146	221251	928011	200784.1
8.00	171353	739763	596274	143489	238863	953685	203074.4

Worksheet calculations
(note must enter n)

Sum X	2306054
Sum X2	9.7E+11
Sum Y	5531845
Sum Y2	4.2E+12
Sum XY	1.8E+12
n	8
A	456724.1
B	0.814400
R sq.	0.501009
S Y/X	183803.2
1/n	0.125
T value	1.76
	3.1E+11

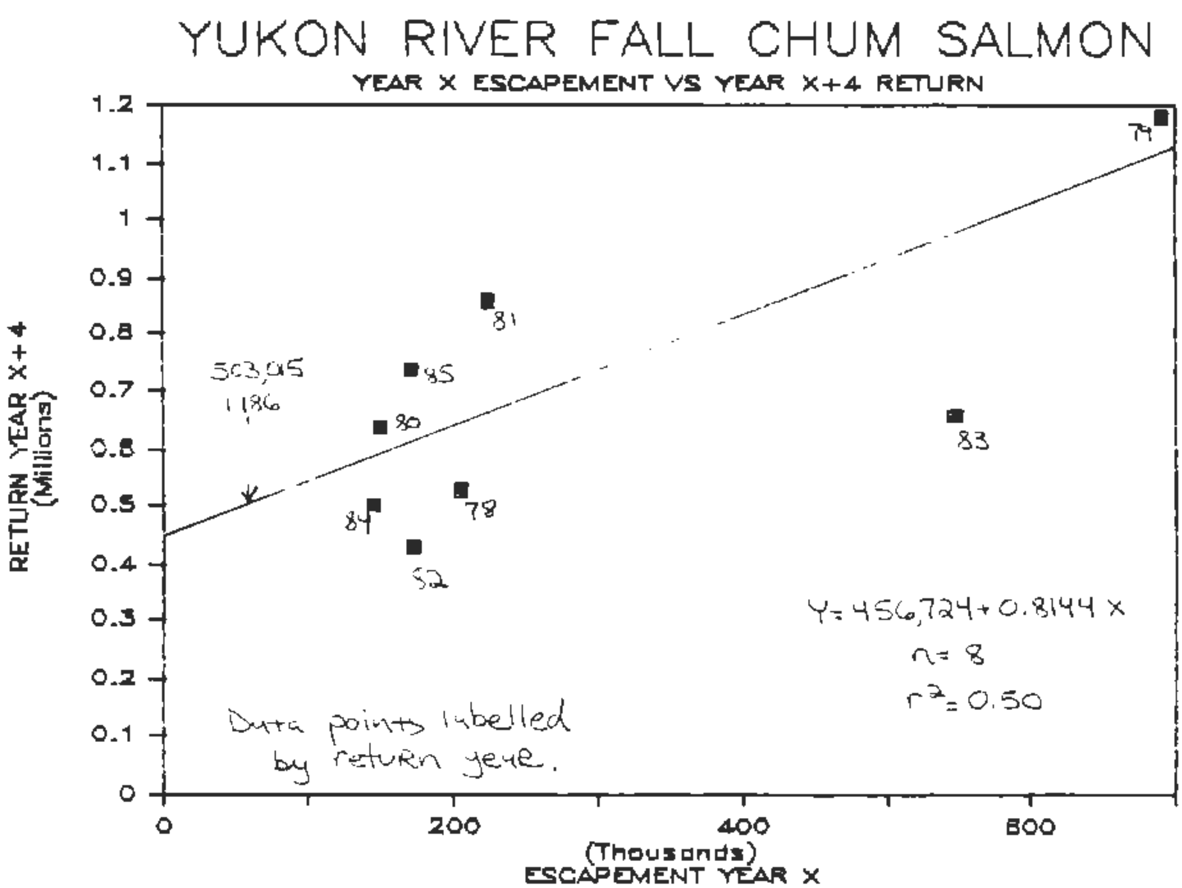


Figure 2.

Simple Linear Regression Worksheet
limit is 100 observations

Obs. Number	X	Y	Pred. Y	Residual	lower 80% C.I.	upper 80% C.I.	St. Dev. Prediction
1.00	263603	1066164	1205039	-138875	726023	1684055	272168.1
2.00	14926	386017	551344	-165327	226410	876279	184621.6
3.00	42848	577746	624743	-46997	295399	954086	187127.0
4.00	54886	527424	656387	-128963	323864	988910	188933.3
5.00	104957	1181049	788008	393041	434617	1141399	200790.3
6.00	86217	637884	738746	-100862	394540	1082953	195571.6
7.00	87390	859703	741830	117873	397095	1086565	195872.0
8.00	12036	429347	543747	-114400	219028	868467	184499.8
9.00	25761	655190	579826	75364	253681	905971	185309.7
10.00	3931	501485	522442	-20957	198079	846805	184297.2
11.00	37110	739763	609659	130104	281564	937755	186417.9

Worksheet calculations
(note must enter n)

Sum X	733665
Sum X2	1.0E+11
Sum Y	7561772
Sum Y2	5.9E+12
Sum XY	6.5E+11
n	11
A	512108.5
B	2.628690
R sq.	0.570779
S Y/X	176427.9
1/n	0.090909
T value	1.76
	5.4E+10

YUKON RIVER FALL CHUM SALMON

AGE 3 VERSUS NEXT YEAR RETURN

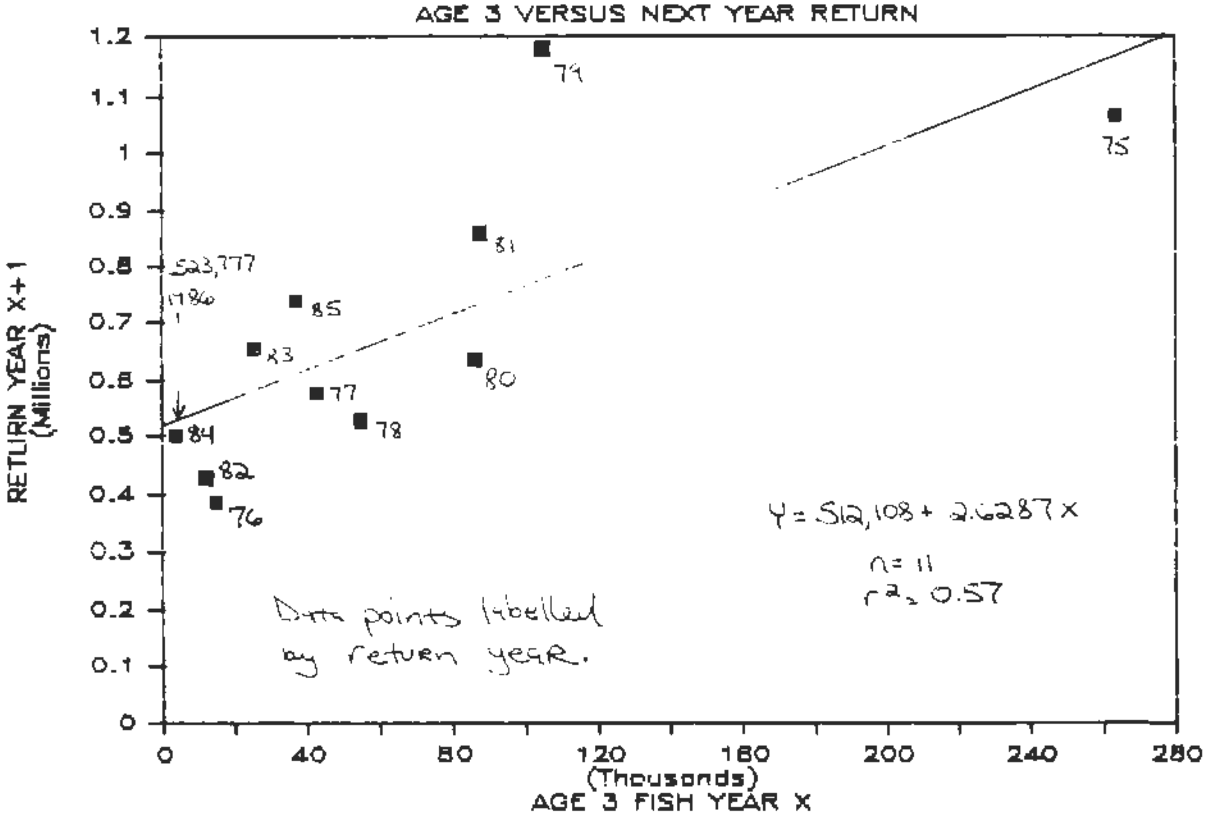


Figure 3.

Simple Linear Regression Worksheet
limit is 100 observations

Obs. Number	X	Y	Pred. Y	Residual	lower 80% C.I.	upper 80% C.I.	St. Dev. Prediction
1.00	263603	1041643	1179853	-138210	652431	1707275	299671.6
2.00	14926	139352	387218	-247866	29448	744988	203278.3
3.00	42848	491662	476217	15445	113592	838842	206036.9
4.00	54886	348100	514587	-166487	148462	880712	208025.7
5.00	104957	1036961	674184	362777	285081	1063286	221080.8
6.00	86217	498825	614452	-115627	235462	993441	215334.8
7.00	87390	753100	618190	134910	238619	997762	215665.5
8.00	12036	266195	378006	-111811	20473	735540	203144.1
9.00	25761	571326	421754	149572	62650	780857	204035.8
10.00	3931	296378	352172	-55794	-4969	709313	202921.0
11.00	37110	631018	457927	173091	96677	819178	205256.1

Worksheet calculations
(note must enter n)

Sum X	733665
Sum X2	1.0E+11
Sum Y	6074560
Sum Y2	4.2E+12
Sum XY	5.8E+11
n	11
A	339642.7
B	3.187408
R sq.	0.617261
S Y/X	194256.6
1/n	0.090909
T value	1.76
	5.4E+10

YUKON RIVER FALL CHUM SALMON

AGE 3 VERSUS NEXT YEAR AGE 4

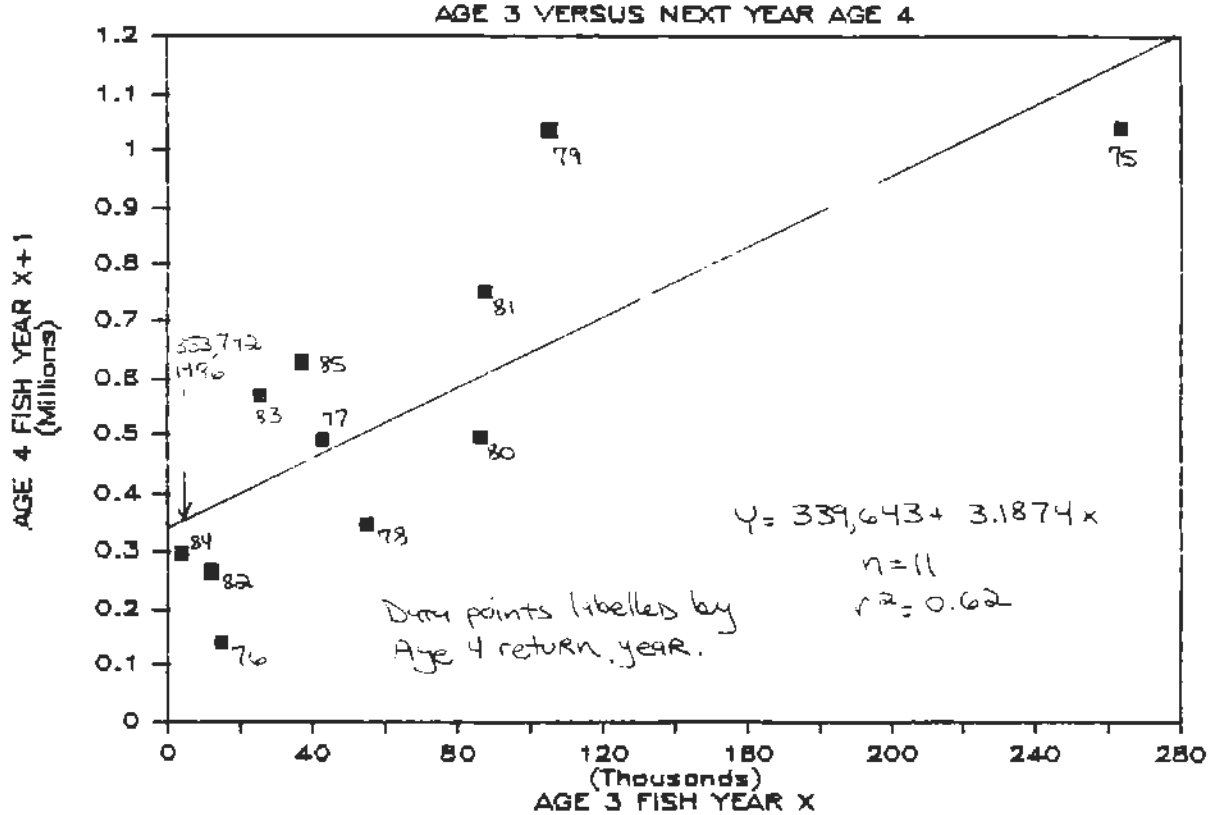


Figure 4.

Simple Linear Regression Worksheet
limit is 100 observations

Obs. Number	X	Y	Pred. Y	Residual	lower 80% C.I.	upper 80% C.I.	St. Dev. Prediction
1.00	321379	5331	68999	-63668	-29674	167672	56064.18
2.00	1041643	204203	146867	57336	11503	282230	76910.99
3.00	139352	30621	49320	-18699	-45563	144203	53910.88
4.00	491662	73312	87408	-14096	-17221	192038	59448.49
5.00	348100	59052	71888	-12836	-27575	171351	56512.88
6.00	1036961	52307	146360	-94053	11312	281409	76732.13
7.00	498825	95427	88183	7244	-16743	193108	59616.75
8.00	753100	135244	115672	19572	-1774	233119	66731.01
9.00	266195	79933	63033	16900	-34192	160258	55241.61
10.00	571326	165490	96021	69469	-12090	204132	61426.68
11.00	296378	99128	66296	32832	-31690	164282	55673.89

Worksheet calculations
(note must enter n)

Sum X	5764921
Sum X2	3.9E+12
Sum Y	1000048
Sum Y2	1.3E+11
Sum XY	6.2E+11
n	11
A	34254.96
B	0.108109
R sq.	0.315025
S Y/X	51126.52
1/n	0.090909
T value	1.76
	9.3E+11

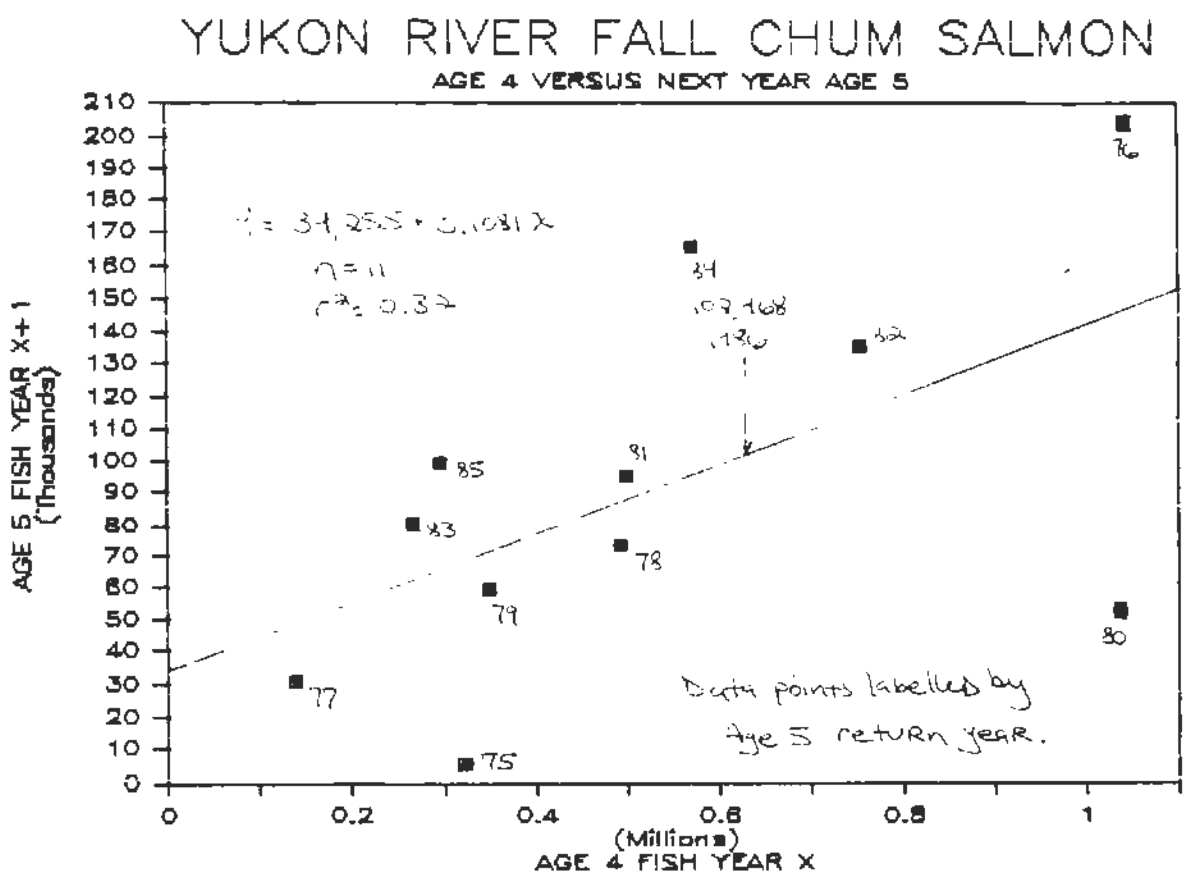
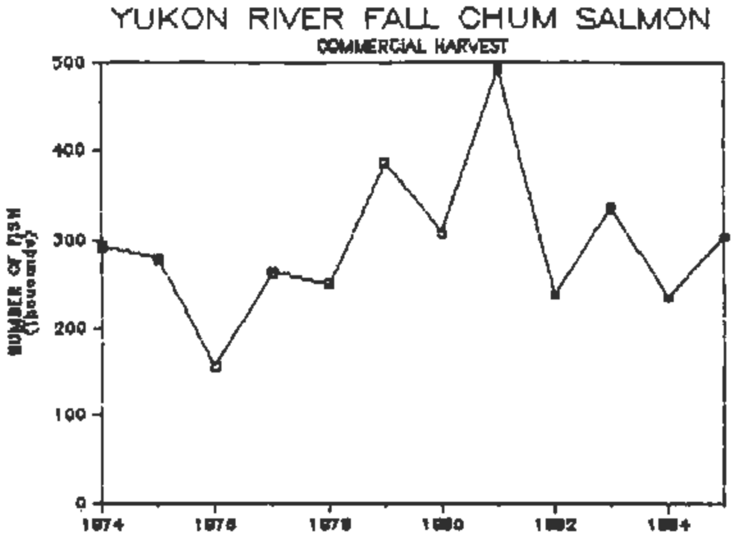
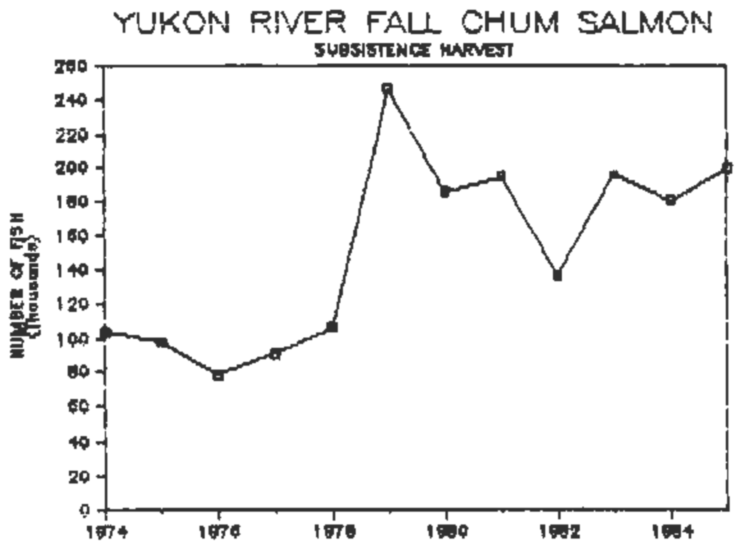


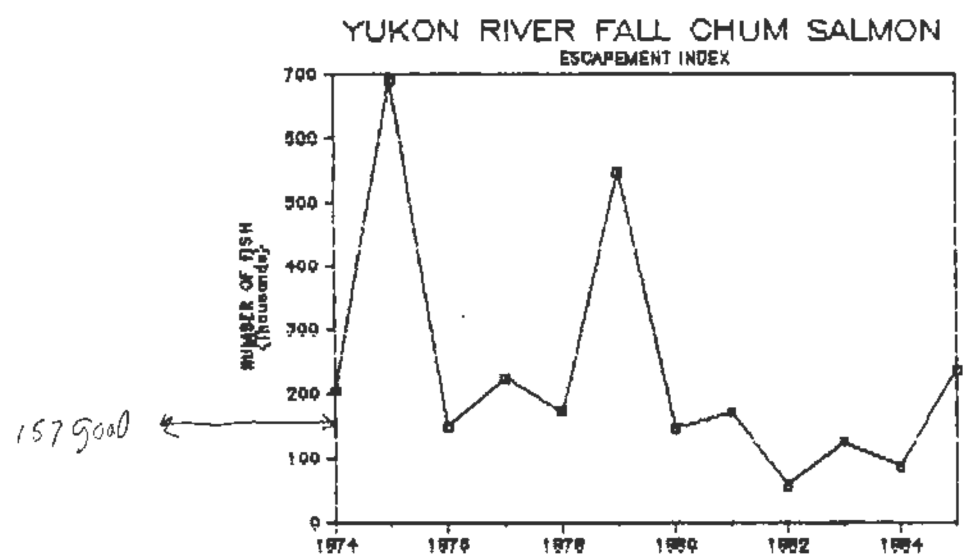
Figure 5.



YUKON RIVER FALL CHUM SALMON
COMMERCIAL HARVEST
NUMBER OF FISH (Thousands)



YUKON RIVER FALL CHUM SALMON
SUBSISTENCE HARVEST
NUMBER OF FISH (Thousands)



YUKON RIVER FALL CHUM SALMON
ESCAPEMENT INDEX
NUMBER OF FISH (Thousands)
157 Goal

Figure 6.

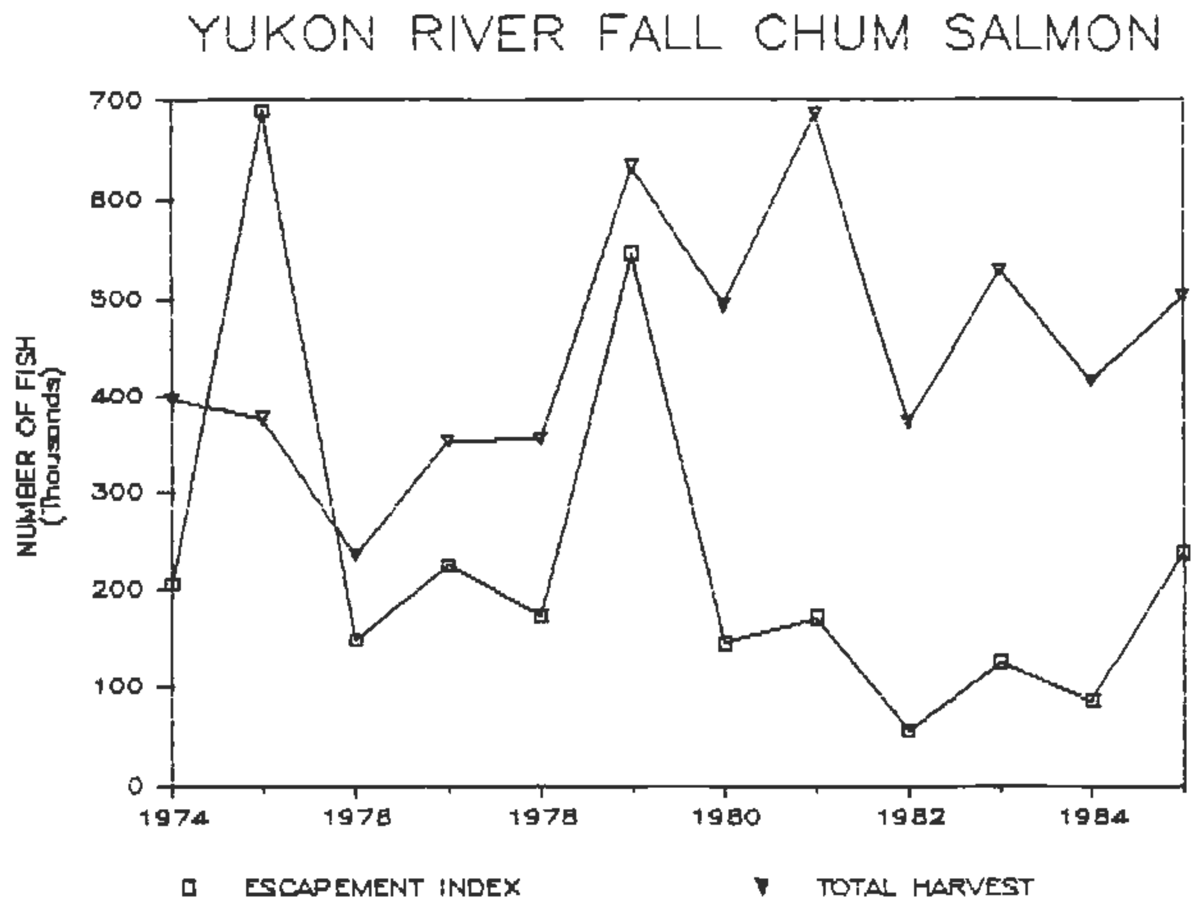


Figure 7.

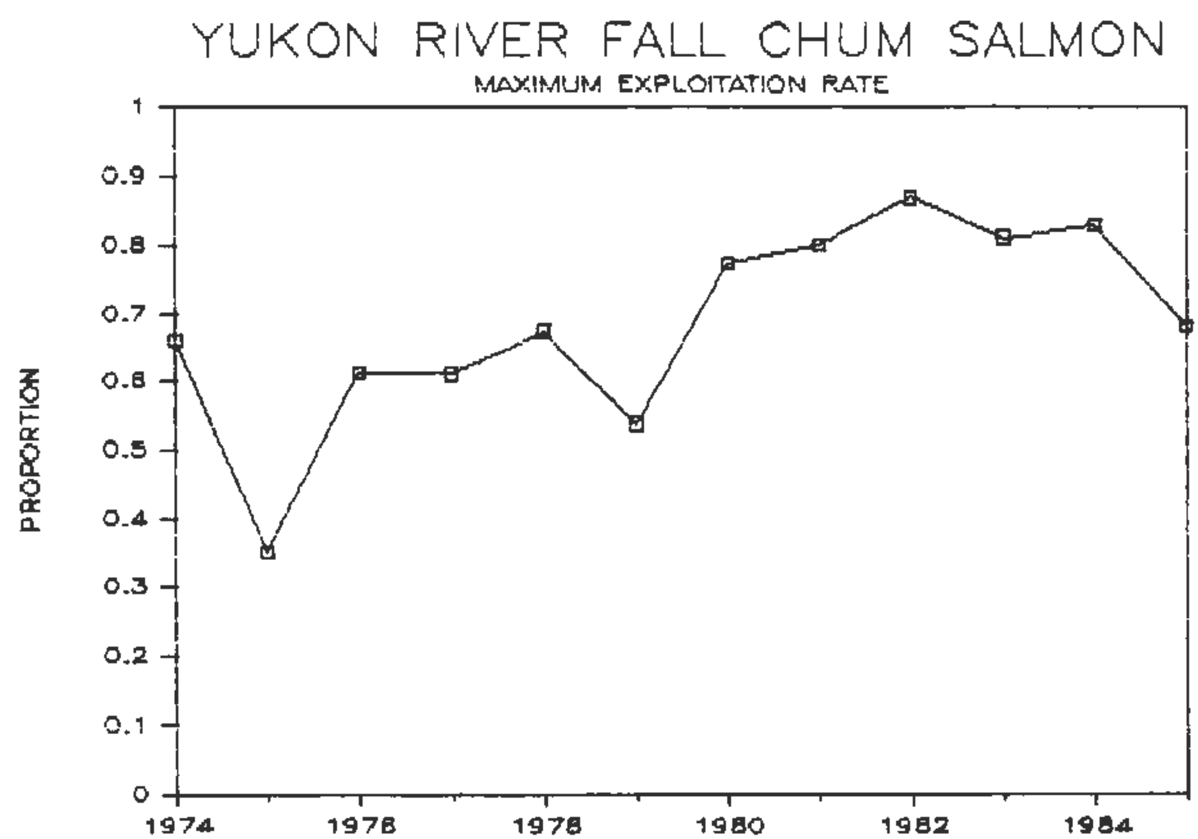
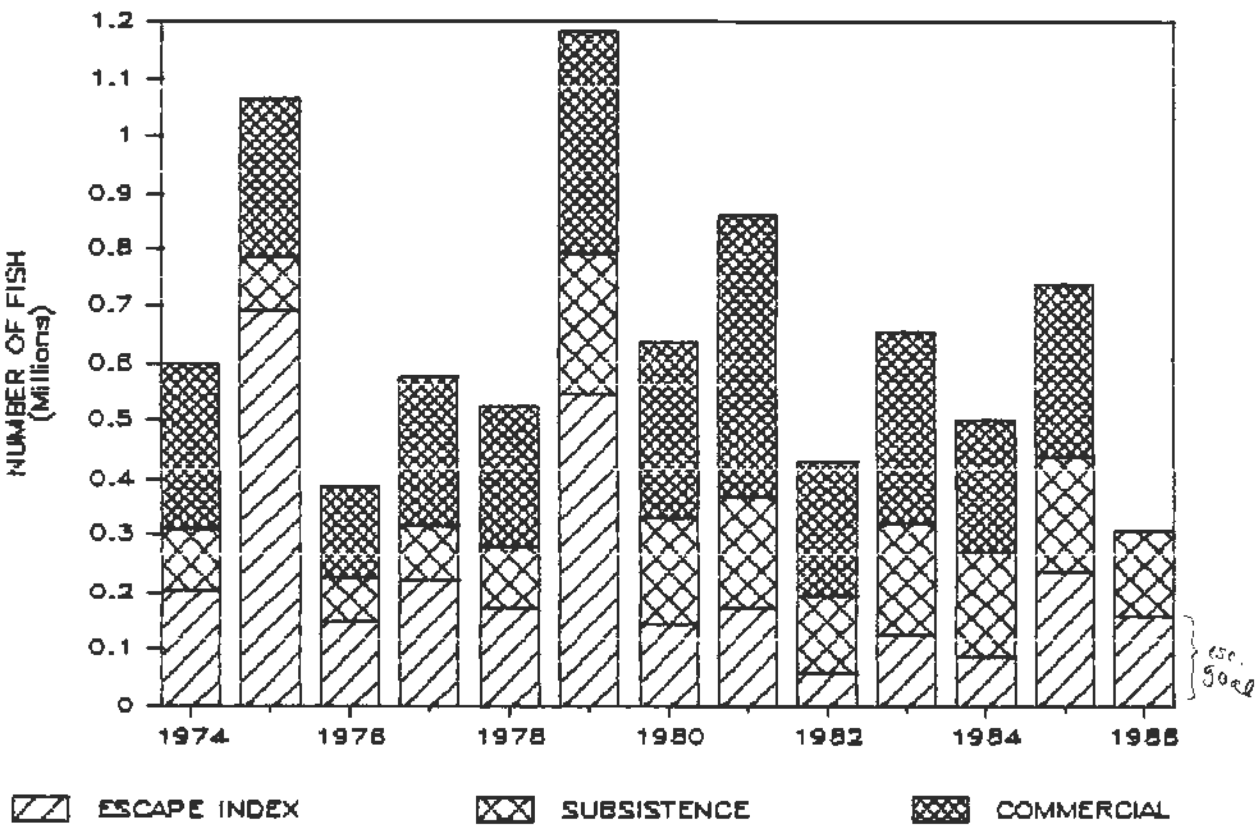


Figure 8.

YUKON RIVER FALL CHUM SALMON



Sheenjek Sonar Ct
Fishing Branch Weir Cr.
Toklat
Delta
Bluff Cabin Cl

expanded survey cts